# CHAPTER 2
# MATERIAL AND CRITERIA

## 2-1. Materials

*a. General.* Although this chapter covers only certain materials and special considerations for those materials when used in particular applications, the category of structures "other than buildings" includes possible applications for virtually any material type. In general, requirements for materials used in structures other than buildings will be in accordance with paragraph 2-2a unless prior approval is obtained from the appropriate headquarters. In addition, consideration will be given to fire protection requirements regarding material selection as set forth in MIL-HDBK-1008A.

*b. Concrete.* Concrete properties will be selected to suit the expected conditions. Type H (modified) or Type V (sulfate resisting cement) will be used for concrete exposed to salt water or similar environments. For further discussion of considerations in selecting appropriate composition and properties for concrete, see Portland Cement Association (PCA) EB00lT. Concrete strengths for structures other than buildings will be in accordance with table 2-1. Concrete cover for protection of reinforcing will be increased when the structure is exposed to salt water or other corrosive conditions unless other means are employed to protect reinforcing from corrosion.

Table 2-1. Concrete Strengths

| Usage | Minimum Strength |
|---|---|
| Mass concrete not exposed to atmospheric conditions or other deteriorating agents where mass rather than strength is the principal considerations. | 2000 psi |
| Drainage and utility structures. | 3000 psi |
| Structures to contain noncorrosive fluids (tanks and reservoirs). | 3000 to 4000 psi |
| Waterfront structures on fresh water. | 4000 psi |
| Reinforced concrete structures over seawater which are sufficiently elevated so that they are not ordinarily wetted by salt water. | 4000 psi |
| Mass concrete exposed to seawater from 3 feet below low water to 3 feet above high water or above normal wave action. | 4000 psi |
| Reinforced concrete decks of waterfront structures where the underside is frequently wetted by salt water. | 4000 to 5000 psi |

*c. Fiber-reinforced concrete.* Concrete and cementitious mortar can be reinforced with alkali-resistant, chopped-glass fibers, short steel fibers, or various organic plastic fibers to obtain enhanced strength, ductility, and toughness when compared to plan concrete and mortar. Fiber-reinforced concrete will be used only if approved by the appropriate headquarters. Design guidance and typical material properties can be found in American Concrete Institute (ACI) 544.1R, 544.2R, 544.3R, 544.4R, SP-81, and SP-105 and in Precast/Prestressed Concrete Institute (PCI) MNL-128.

*d. Steel materials.* Structural steel materials for typical applications will conform to American Society for Testing and Materials (ASTM) A 36, A 53, A 500, and A 572.

*(1) Corrosion-resistant steel.* Use of corrosion-resistant steel will be in accordance with the following. Steel conforming to ASTM A 690 wilibe used asset forth in MIL-HDBK-1025/6. Use of corrosion-resistant steel conforming to ASTM A 242 or A 588 is restricted. This type of steel will not be used in areas where the atmosphere contains salt spray and will not be used in a seawater environment. It offers no benefit, and ASTM A 36 material is a better choice. This type of steel will not be used in buried structures unless coated nor will it be used in locations where rust staining of the supporting elements is objectionable.

*(2) Stainless steel.* Use of stainless steel conforming to ASTM A 666, Types 306 or 316 is restricted. This material will not be used in salt spray zones, in buried applications,

or in an aqueous environment where contact with oxygen is precluded. (In such situations, e.g., under washers, accelerated corrosion will occur.)

*(3) Climatic and temperature considerations.* Special requirements will be considered for applications in severe cold (minimum toughness) or elevated temperatures (reduced yield and tensile strength) as set forth in paragraph 2-2a.

*(4) Abrasive wear.* Additional thickness will be provided in locations subject to abrasive wear, and use of replaceable wear plates for severe conditions will be considered.

*e. Timber materials.* Design requirements for timber materials will be in accordance with paragraph 2-2a.

*f. Aluminum materials.* Design requirements for aluminum materials will be in accordance with paragraph 2-2a.

*g. Composite construction.* Composite construction includes construction such as cast-in-place concrete bonded or connected to precast members, cast-in-place concrete bonded or connected to structural timber, sandwich panels having relatively stiff and strong facings bonded to lightweight cores of lesser strength, such as concrete over rigid insulation, etc. Composite construction has applicability to certain types of structures as covered in MIL-HDBK-1002/6. Composite construction also includes cast-in-place concrete used in conjunction with structural steel or metal decking. Design guidance for these types of composite construction is given in MIL-HDBK-1002/3. Applicable references for composite construction are ACI 318, Chapter 17; PCI MNL-120 and PCI MNL-126; American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges; National Forest Products Association National Design Specification for Wood Construction (timber portion) and ACI 318 (concrete portion); and American Institute of Timber Construction (AITC) Timber Design Handbook (2nd Edition, 1974, covers past practice — not covered in current edition). The combined action of flexible and rigid shear connectors will not be considered as providing simultaneous shear transfer. Rigid connectors include roughened and adhered surfaces and structural shapes. Flexible connectors include items such as bolts, stirrups, dowel bars, and ties.

*h. Composites and structural plastics.* Composites and structural plastics have limited applicability to military construction and then only to selected specialty structures. Composites and structural plastics will be used only when approved by the appropriate headquarters. Among the concerns associated with structural plastics are fire resistance characteristics and properties which generally do not conform to military fire protection criteria. Precautions will be observed when using composites and structural plastics in recognition of their unfavorable fire resistance properties.

## 2-2. Criteria

a. *General.* For a general discussion of considerations such as material selection, service life, etc., which are applicable to all structures, refer to TM 5-809-2/AFM 88-3, Chapter 2.

*b. Design loads.* Design loads will be determined and established in accordance with TM 5-809-1/AFM 88-3, Chapter 1, or MIL-HDBK-1002/2 except where provided otherwise by this manual or other established standard applicable to the type of structure under consideration. Seismic loading will be in accordance with TM 5-809-10/NAVFAC P-355/AFM 88-3, Chapter 13. Loadings not covered by the criteria in this manual will be obtained from available technical literature, manufacturer's brochures, or will be carefully formulated. In case of any conflict between criteria and available data, the most current acceptable data or practice will be used. Particular attention will be given to wind, seismic, dynamic, and fatigue loads on cable-supported structures and other similar force-oscillating structures.

*c. Design stresses.* Allowable stresses or load factors applicable to the various materials which may be used will conform to TM 5-809-2/AFM 88-3, Chapter 2, unless indicated otherwise by paragraph 2-2d.

*d. Design requirements.* Designs will conform to the general concepts and practices of the proper design specification listed in this manual. Where the design of a particular structure or of a special case is not covered, the design approach and technical formulas will be based on available technical literature or will be carefully formulated. Wherever possible, standard, easy-to-get materials will be specified. New materials, units, and systems of a progressive nature or creative design concepts that are economically and structurally sound may be considered. In all cases, the design method, structural framing system, and materials will be the most economical, effective, and efficient from the standpoints of the structure's initial and maintenance costs and its design life. If there are conflicts among the criteria given in this manual for a specific type of structure, the most conservative design method will be used. This will not preclude, however, the use of new codes or specifications which, although less conservative, are considered acceptable for military construction.

*e. Design details.*

*(1) Drainage.* A proper drainage system will be provided for the following conditions or locations:

*(a)* All structural surfaces exposed to weather will be sloped to drain.

*(b)* Intersecting surfaces forming valleys or pockets that may retain water will be arranged to provide drainage.

*(c)* Structural steel and wood members will be designed so they will not retain moisture or, when in pairs or multiples, so water or moisture will not be held between members.

*(d)* Structural items like expansion plates, rocker joints, and surfaces intended to permit movement will be designed so they are protected against direct contact with water or condensation and will be detailed to readily drain water.

*(e)* Surfaces and members will be designed so water will drain from points where steel contacts or enters into masonry or concrete.

*(2) Exposed conditions.*

*(a)* Wherever possible, contact between masonry and wood or metal in exposed conditions will be prevented. Usually, the best way to drain masonry is to put weep holes where they will not adversely affect member strength.

*(b)* Where exposed and uncoated steel structures are used, an increased thickness of at least 1116 inch for corrosion allowance will be used over the computed thickness required. No corrosion allowance for corrosion-resistant or weathering steel is required.

*(c)* Exposed concrete structures will have enough protective concrete cover to protect the reinforcement. The concrete mixture will be of maximum density and minimum shrinkage, especially with regard to longtune shrinkage and expansion which may be caused by alternate wetting and drying. For bridges or structures exposed to corrosive chemicals or deicing salt, epoxy coated reinforcing bar, a densely mixed overlay, or both will be provided to prevent corrosion of reinforcing steel. Specific guidance should be obtained from local or state highway department officials. Bridge decks subject to repeated applications of deicing salt will require more than additional concrete cover for reinforcing. Epoxy coated reinforcing bars and densely mixed concrete overlays are considered the most effective methods and are approved by the Federal Highway Administration.

*(d)* Vertical expansion and contraction joints for reinforced concrete retaining walls and similar structures will be spaced sufficiently close to reduce or eliminate wall cracking due to shrinkage and expansion.

*(e)* In coastal areas, continuous concrete or masonry foundation walls or grade beams will be extended 24 inches above grade for wood or steel exterior walls so the junction will be above the splash zone.

*(3) Buried or semi-buried structures.* Structures of this type will be designed to resist buoyant forces caused by the presence of water. The safety factor will be at least 1.5 at maximum water table using the dead weight of the structure without contents plus the weight of earth cover directly over the tank. A safety factor of 1.1 may be used when the maximum water table or the maximum flood level is at or above the top of the structure. Designers will consider the possible hydrostatic uplift at various stages of construction.